SEMESTER III

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MAL20A	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BSC	3	1	0	0	4	2023

i) COURSE OVERVIEW

This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. The basic theory of functions of a complex variable, residue integration and conformal transformation are discussed.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Solve partial differential equations.	Apply
CO2	Use appropriate methods to solve one dimensional wave equation and heat equation.	Apply
CO3	Solve problems using analyticity of complex functions	Apply
CO4	Find the image of regions under conformal mapping	Apply
CO5	Find complex integrals using Cauchy's formulas to compute several kinds	Apply

iii) SYLLABUS

Partial differential equations: Formation of partial differential equations, Solutions of a partial differential equations, Linear equations of the first order, Method of separation of variables.

One dimensional wave equation-derivation and solution -One dimensional heat equation, derivation and solution

Complex Differentiation: Analytic functions, Cauchy-Riemann equations, harmonic functions, Conformal mappings- standard mappings, Linear fractional transformation.

Complex integration: Line integrals in the complex plane, Contour integrals, Cauchy integral theorem, Cauchy Integral formula

Taylor's series and Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem, Evaluation of definite integral using residue theorem.

iv) a) TEXTBOOKS

1) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

b) REFERENCES

1) J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017.
2) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th

Edition, Pearson, Reprint, 2002.
3) Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method Boundary value problems, Method of separation of variables.	**12**
II	One dimensional wave equation- vibrations of a stretched string, Derivation. Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D'Alembert's solution of the wave equation One dimensional heat equation, derivation. Solution of the heat equation using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation- Laplace's equations - Derivation and solution by method of separation of variables.	**13**
III	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations - harmonic functions, finding harmonic conjugate - Conformal mappings - mappings of w = z^2, w = e^z, w = 1/z , $w = sinz$	**12**
IV	Complex integration, Line integrals in the complex plane, Basic properties, first evaluation method, second evaluation method, use of representation of a path-Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain (without proof). Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function Taylor's series and Maclaurin series.	**11**
V	Laurent's series (without proof)-zeros of analytic functions, singularities, poles, removable-singularities, essential singularities, Residues,Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem-Residue integration of real integrals –integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form ∫_(-∞)^∞▒f(x)dx with no poles on the real axis. (∫_A^B▒f(x)dx whose integrand become infinite at a point in the interval of integration is excluded from the syllabus)	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEB20A	LOGIC SYSTEM DESIGN	PCC	3	1	2	0	5	2023

i) COURSE OVERVIEW:

The Goal of this course is to expose the students to acquire the basic knowledge of digital logic levels and application of knowledge to understand the Digital Electronic Circuits. Students will be able to analyze, design and Implement Combinational and Sequential Circuits. This course also gives an introduction to students on designing Digital circuits using Verilog Programming.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Classify various number systems, binary codes and formulate digital functions using Boolean algebra.	Apply
CO2	Construct various Combinational logic circuits.	Apply
CO3	Model various Sequential logic circuits.	Apply
CO4	Develop Sequential circuits using PLDs.	Apply
CO5	Model Combinational and Sequential logic circuits using HDL.	Apply

iii) SYLLABUS

Introduction to various number representations –Digital Logic Families - Logic Gates- Boolean Algebra - De Morgan's Theorem - Karnaugh Map.
Combinational Logic Design - Sequential Logic Design – Counters - Asynchronous and synchronous, Ring and Johnson counters - Mealy/Moore models state diagram, state table.
Programmable Logic Devices - ROM, PLA, PAL, FPGA - Verilog Coding.

iv) (a) TEXT BOOKS

1) M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, Pearson ,6th edition, May 2018
2) Thomas L. Floyd, Digital Fundamentals, Pearson Education, 10th Edition, 2011.
3) Roth C. H., Kimney L. L., Fundamentals of Logic Design, Cengage Learning, 7th Edition 2013.
4) Mano M. M., Logic and Computer Design Fundamentals, Pearson Education, 4th Edition, 2008.
5) Salivahanan S., Arivazhagan S., Digital Electronics, Vikas Publishers, 5th Edition 2018.
6) Roy Chaudari, Linear Integrated Circuits, New Age International Publications, 5th Edition, 2018.

(b) REFERENCES

1) Ronald J. Tossi, Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Pearson Education, 10th Edition, 2011.
2) John F. Wakerly, Digital Design: Principles and Practices, Pearson, 4th Edition ,2005.
3) Anand Kumar A., Fundamentals of Digital Circuits, Prentice Hall of India, 4th Edition, 2016.
4) Donald P. Leach, Albert Paul Malvino, Digital Principles and Applications, Tata Mc Graw Hill, 8th Edition, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	Number system and codes: Binary, octal, hexadecimal and decimal number systems - their inter conversion and arithmetic, BCD number system. Gray code, excess–3 code, code conversion, ASCII, EBCDIC codes, Error detection codes. Binary addition and subtraction, signed and unsigned binary numbers arithmetic, 1's and 2's complement representation.	**8**
II	Boolean Algebra and Logic gates- Theorems and properties of Boolean Algebra, Canonical and standard forms, Digital logic gates, Gate level minimization – Four variable K map, don't care conditions, Hardware Description Language.	**8**
	Laboratory Experiments: Realization of SOP, POS functions after K-map reduction.	**2**
III	Combinational Logic: Combinational Circuits- Binary Adder – Subtractor, Decimal Adder, Magnitude Comparators, Decoders, Encoders, Multiplexers, De multiplexers, Code Converters, HDL model of combinational circuits	**10**
	Laboratory Experiments: Half adder and Full adder using gates. Realization of 2-bit comparator using gates, BCD to decimal decoder, Study of multiplexer IC and realization of combinational circuits using multiplexer	**10**
IV	Synchronous Sequential Logic: Sequential circuits, Storage elements – Latches and Flip Flops, Conversion of Flip Flops. Registers and Counters: Shift registers, Ripple Counters, Synchronous Counters, HDL model of Sequential circuits	**11**
	Laboratory Experiments: Realization of SR, T, D JK flip flops using gates, Study of flip flop ICs, Realization of ripple up and down counters and modulo-N counter using Flip flops, Study of counter ICs (7490, 7493, Design of synchronous up, down and modulo-N counters, Realization of 4-bit serial IN serial OUT registers with flip flops, Realization of shift register, ring counter and Johnson Counter.	**18**
V	State machines – Mealy and Moore, Programmable logic devices, Case study using Programmable logic device (PLD).	**8**
	Total hours	**75**

Sl. No	Laboratory Program/Experiment	No of Hours
1	Realization of De Morgan's theorem, Realization of SOP, POS functions after K-map reduction.	2
2	Half adder and Full adder using Universal gates.	2
3	Realization of 2-bit comparator using gates and study of 4 bit comparator IC	2
4	4-bit adder/subtractor and BCD adder using IC 7483.	2
5	BCD to decimal decoder and BCD to 7-segment decoder display	2
6	Study of multiplexer IC and realization of combinational circuits using multiplexer	2
7	Realization of SR, T, D JK flip flops using gates	2
8	Realization of ripple up and down counters and modulo-N counter using Flip Flops	4
9	Design of synchronous up, down and modulo-N counters.	4
10	Realization of 4-bit serial IN serial OUT registers using flip flops	4
11	Realization of shift register, ring counter and Johnson counter	4
	TOTAL	**30**

vi) ASSESSMENT PATTERN

Continuous Assessment	
Attendance	5 marks
Assignment / Project Work	15 marks
Assessment through Tests	20 marks
Assessment of Lab Work	10 marks
Lab Exam	10 marks
Total Continuous Assessment	**60 marks**
End Semester Examination	**40 marks**
TOTAL	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules (approx.)

END SEMESTER EXAMINATION

Maximum Marks: 40

Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL20B	MEASUREMENTS AND INSTRUMENTATION	PCC	3	1	0	0	4	2023

Pre-Requisite: 23ESL10J - Basics of Electrical Engineering A

i) COURSE OVERVIEW:

This course deals with the construction and principle of operation of basic analog and digital instruments used for measurement of current, voltage, power, energy etc. It provides a detailed study of resistance, inductance and capacitance measuring methods. The course includes an elaborate discussion about potentiometers and instrument transformers. It introduces students to the operation of various transducers to measure the physical quantities.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Compare the different types of analog and digital measuring instruments, their construction, operation and characteristics.	Understand
CO2	Explain the construction and working of Watt meters, Energy meters and DC potentiometers.	Understand
CO3	Use different bridges to measure the Resistance, Inductance and Capacitance	Apply
CO4	Identify various methods for magnetic measurement, high voltage and high current measurements.	Apply
CO5	Summarize the construction and working of various transducers to measure the physical quantities	Understand

iii) SYLLABUS

General principles of measurements, Classification of meters, Ammeters and voltmeters - moving coil, moving iron meters

Measurement of power and energy: Dynamometer type wattmeter, Induction type 1 phase energy meter, DC potentiometers, High voltage and high current measurements- Current transformers and potential transformers

Measurement of resistance, self-inductance, capacitance and frequency: Ammeter voltmeter method-Kelvin's double bridge, Wheatstone's bridge, earth resistance, Maxwell's Inductance bridge, Schering's, Wien's bridge, DC potentiometer.

Magnetic Measurements: flux meter, BH curve and permeability measurement - ballistic galvanometer. Lloyd Fisher square

Oscilloscopes- Principle of operation of general purpose CRO, Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.

Transducers - Definition and classification. Photoconductive Transducers-Photovoltaic cells, LVDT, Piezoelectric force transducer, Load cell, Strain gauge, RTD, Thermistors, thermocouple. Digital Measurement of Electrical Quantities.

iv) (a) TEXT BOOKS

1) Sawhney A. K., "A course in Electrical and Electronic Measurements and instrumentation", Dhanpat Rai & Co. (P), 10th Edition, 2015.
2) Golding E.W., Widdis F. C., "Electrical Measurements and Measuring Instruments", Wheeler Publications, 15th Edition, 1998.
3) Albert Helfrick D., Cooper William D., "Modern Electronic Instrumentation and Measurement Techniques", Pearson Education, 2016.

(b) REFERENCES

1) Gupta J. B., "A course in Electronic and Electrical Measurement and Instrumentation", S K Kataria & Sons, 13th Edition, 2007.
2) Kalsi H. S., "Electronic Instrumentation", Tata McGraw Hill, 3rd Edition, New Delhi, 2012.
3) Stout M. B., "Basic Electrical Measurements", Prentice Hall, 2nd Edition, 1973.
4) Bernard Oliver M., John Cage M., "Electronic Measurements and Instrumentation", McGraw Hill, 2000.
5) Er. Yogita Kumari, Dr. Hrisheekesha P.N., Er. Shiv Prakash Bihari, "Digital Measurement Techniques", JBC Press, 1st Edition, 2015.
6) Rathore T. S., "Digital Measurement Techniques", Narosa publications, 2nd Edition, 2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	Measurement standards–Errors-Types of Errors- Statistics of errors, Need for calibration. Classification of instruments, secondary instruments–indicating, integrating and recording operating forces - essentials of indicating instruments - deflecting, damping, controlling torques. Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles, shunts and multipliers – extension of range.	**11**
II	Measurement of power: Dynamometer type wattmeter – Construction and working - 3-phase power measurement - Low Power factor wattmeters. Measurement of energy: Induction type watt-hour meters - Single phase energy meter – construction and working, two element three phase energy meters, Digital Energy meters - Time of Day (TOD) and Smart metering (description only). Current transformers and potential transformers – principle of working - ratio and phase angle errors. Extension of range using instrument transformers, Phasor Measurement Unit (PMU) (description only).	**13**
III	Classification, measurement of low, medium and high resistance- Ammeter voltmeter method (for low and medium resistance measurements)-Kelvin's double bridge, Wheatstone's bridge - loss of charge method, measurement of earth resistance. Measurement of self-inductance-Maxwell's Inductance bridge,	**12**

	Measurement of capacitance – Schering's, Measurement of frequency-Wien's bridge. Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers. High voltage and high current in DC measurements- voltmeters, Sphere gaps, DC Hall effect sensors.	
IV	Magnetic Measurements: Measurement of flux and permeability - flux meter, BH curve and permeability measurement - hysteresis measurement- ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square - measurement of iron losses. Oscilloscopes- Principle of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques. Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.	**12**
V	Transducers - Definition and classification. Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells, Temperature sensors - Resistance temperature detectors-negative temperature coefficient Thermistors-thermocouples-silicon temperature sensors. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge. Introduction to Virtual Instrumentation systems- Simulation software's (description only).	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL20C	ELECTRIC CIRCUIT ANALYSIS	PCC	3	1	0	0	4	2023

Pre-Requisite: 23MAL10B - Vector Calculus, Differential Equation and Transforms, 23ESL10J - Basics of Electrical Engineering A

i) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of AC and DC circuits, enhance the problem-solving skills by using various techniques to solve different types of circuits. Time Domain analysis will help students to understand the transient and the steady-state response of R, L, C circuits. The course also aims to introduce two port network modeling and network functions.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Apply circuit theorems to simplify and obtain responses in complex DC and AC electric networks.	Apply
CO2	Solve DC and AC circuits to obtain the complete response to various excitations.	Apply
CO3	Solve dynamic circuits by applying transformation to s-domain.	Apply
CO4	Solve magnetically coupled circuits and resonant circuits	Apply
CO5	Develop two-port network representation using network parameters.	Apply

iii) SYLLABUS

Network theorems - DC and AC steady state analysis. Time domain analysis of dynamic circuits -steady state and transient response analysis - Introduction to Laplace Transform - Application of Laplace transform in series and parallel circuits with step and sinusoidal responses. Coupled circuits - Dot convention - Analysis of simple coupled circuits, Resonance in series and parallel circuits. Two port network - network parameters - interrelationship of network parameters - driving point and transfer immittance function.

iv) (a) TEXT BOOKS

1) Hayt and Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, New Delhi, 9th Edition, 2019.

2) Ravish R. Singh, “Network Analysis and Synthesis”, McGraw-Hill Education, 2013.

3) Sudhakar and Shyam Mohan, “Circuits and Networks: Analysis and Synthesis”, McGraw Hill Education, 5th Edition, 2015.

4) F. F. Kuo, “Network Analysis and Synthesis”, John Wiley Inc Publications, 1966.

(b) REFERENCES

1) Joseph A. Edminister and Mahmood Nahvi, "Electric Circuits", McGraw Hill, 7th Edition, 2017.
2) A. Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co., 7th Revised Edition, 2018.
3) Choudhury Roy D., "Networks and Systems", New Age International Pvt. Ltd. Publishers, 2nd Edition, 2013.
4) Van Valkenberg, "Network Analysis", Prentice Hall India Learning Private Limited, 3rd Edition, 2011.
5) Dr. B.R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 3rd Edition, 2013.
6) C. A. Desoer, E. S. Kuh, "Basic Circuit Theory", McGraw-Hill, New York, 1969.
7) James W. Nilsson and Susan A. Riedel, "Electric Circuits", Pearson Education Publications, 9th Edition, 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of circuit elements, fundamental laws, AC representation. Circuit theorems: Thevenin theorem, Norton's theorem, Superposition theorem, Maximum Power transfer Theorem, Reciprocity theorem. DC and Sinusoidal steady state analysis of circuits with dependent and independent sources.	**12**
II	Time domain analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms - Damping ratio -Over damped, under damped, critically damped and undamped RLC networks.	**14**
III	Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation - Poles and zeros.	**10**
IV	Analysis of Coupled Circuits: Dot polarity convention -Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain. Resonance in Series and Parallel RLC circuits: Quality factor - Bandwidth -Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.	**11**
V	Two port networks: Driving point and transfer functions - Z, Y, h and T parameters - Conditions for symmetry & reciprocity - relationship between parameter sets interconnections of two port networks (series, parallel and cascade) - T-pi transformation.	**13**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ESL00A	DESIGN ENGINEERING	ESC	2	0	0	0	2	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are required to utilize design thinking as a crucial and pertinent approach to learning, reflecting its significance and relevance in contemporary contexts. The course also focuses on familiarizing the students with the concepts of innovative idea generation and presentation along with its market viability and business model.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Demonstrate the ability to effectively apply the principles of the design process in solving real-world engineering challenges.	Apply
CO2	Analyse user needs and frame well-defined problem statements.	Analyse
CO3	Create innovative ideas to solve real-world problems by applying the principles of Design Thinking.	Create
CO4	Explain the concepts of Modular design, Ergonomics and Aesthetics to address design challenges.	Understand
CO5	Create a pitch deck and deliver a presentation that effectively communicates an innovative idea.	Create

iii) SYLLABUS

Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test.

Empathize: Understanding User Needs, Define- Framing the Problem. Translating empathy findings into actionable problem statements.

Ideate: Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. Prototype: Inexpensive prototypes to quickly explore and iterate on ideas. Test: Gathering feedback from real users through interactions

Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability.

Product Viability and Business Model- Value Proposition, Market Opportunity, Cost-Revenue Relationship, Technology and Implementation, Competitive Analysis, Traction and Milestones.

iv) a) TEXTBOOKS

1. Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, Engineering Design Process, Third Edition, Cengage Learning, January 2017
2. Michael Lewrick, Patrick Link, Larry Leifer, Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Wiley Publications, June 2018
3. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley Publications, April 2020
4. A Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want, Wiley Publications, October 2014

b) REFERENCES

1. Dr. Amitkumar Goudar, The Secrets of Design Thinking Mindset: More Tools and Techniques To Enhance Your Design Thinking Skill, Clever Fox Publishing, October 2023
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving, Penguin Random House India Private Limited, 2020
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business; Revised, Updated edition, March 2019
4. Don Norman, The Design of Everyday Things, Basic Books; 2 edition November 2013
5. Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

iv) COURSE PLAN

Module	Contents	No. of hours
I	**Design Process**: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	**3**
	Practical Exercise: Need Identification Case studies. How to define a Problem Statement. Present an idea using the stages of the Design Process.	**3**
II	**Design Thinking Approach** - Introduction to Design Thinking. Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. **Empathize:** Understanding User Needs, Gathering meaningful insights from users. **Define:** Framing the Problem. Translating empathy findings into actionable problem statements. Utilizing tools such as	**3**

	problem statements, point-of-view statements, and user personas.	
	Practical Exercise: Analyse user needs and frame well-defined problem statements	**3**
III	**Ideate:** Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. **Prototype:** Low-Fidelity Prototyping: Building rough, inexpensive prototypes using materials like paper, cardboard, or digital wireframes to quickly explore and iterate on ideas. **Test:** Gathering feedback from real users through interviews, surveys, or usability tests to evaluate prototypes and refine designs.	**3**
	Practical Exercise: Design Thinking in a Team Environment. Create innovative ideas to solve real-world problems by applying the principles of Design Thinking	**3**
IV	**Design Engineering Concepts:** Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability. **Design Communication:** Communicating Designs Graphically, Communicating Designs Orally and in Writing.	**3**
	Practical Exercise: Apply the concepts of Modular design, Ergonomics and Aesthetics to address design challenges.	**3**
V	**Product Viability and Business Model:** Customer Segments, Value Proposition, Market Opportunity, Cost- Revenue Relationship, Technology and Implementation, Competitive Analysis, Traction and Milestones.	**3**
	Practical Exercise: Create a Pitch deck and make a presentation of the idea generated along with its business model.	**3**
	Total hours	**30**

v) ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Test	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Evaluation (Design Presentation)	:	**60 marks**

End Semester Evaluation (60 Marks)

The end semester evaluation for Design and Engineering will consist of a group presentation, with a maximum group size of 5 students. Students will be required to apply the fundamentals of design thinking learned during the course to identify and address a problem statement. The problem statement shall be selected from the pool of problems provided by various Government departments and industries listed in initiatives such as Smart India Hackathon or Young Innovators Programme or their own solution to a potential regional real-world problem.

Mark Distribution for Design Presentation (60 Marks):

Understanding of User Needs and Problem Statement: 10 marks

Demonstrating a clear understanding of user needs and articulating a well-defined problem statement.

Creativity and Innovation in Solution Design: 10 marks

Presenting innovative and creative solutions that address the identified problem statement effectively.

Product Market Fit: 10 Marks

Evaluating the market potential and ensuring alignment between the proposed solution and market demands.

Clarity and Effectiveness of Presentation: 10 marks

Delivering a clear and engaging presentation that effectively communicates the proposed solution and its benefits.

Competitive Analysis: 10 Marks*Conducting a thorough analysis of competitors and market dynamics to inform strategic decision-making.*

Individual and Teamwork: 10 Marks

Assessing individual contributions to the presentation as well as the effectiveness of teamwork and collaboration within the group.

This evaluation format provides students with an opportunity to apply their knowledge and skills in design thinking to real-world problems, while also evaluating their ability to work effectively in teams and deliver compelling presentations.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23HSL2NA	PROFESSIONAL ETHICS	HSC	2	0	0	0	1	2023

i) COURSE OVERVIEW

The objective of this course is to create an awareness on engineering ethics and human values. The course also aims to instill moral and social values, loyalty and also to learn to appreciate the rights of others

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Identify different skills required in personal life.	Understand
CO2	Apply well-defined techniques to cope with emotion and stress.	Apply
CO3	Solve moral and ethical problems in professional life.	Apply
CO4	Explain the core values that shape the ethical behaviour of a professional.	Understand
CO5	Solve moral and ethical problems through explorations and assessment by established experiments.	Apply
CO6	Apply the knowledge of human values and social values to contemporary ethical values and global issues	Apply

iii) SYLLABUS

Meaning and significance of life skills. Life skills identified by WHO: Self-awareness, Empathy, Decision making, problem solving, interpersonal relationship, coping with stress, coping with emotion. Self-awareness: Definition, need for self-awareness; Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback Stress Management: Stress, reasons and effects, stress diaries, the four A's of stress management, techniques, approaches: action- oriented, emotion-oriented, acceptance-oriented, resilience, Gratitude training

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques

Life skills for Professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, motivation, personality development, IQ, EQ and SQ Responsibilities and Rights.– Collegiality and loyalty- Managing conflict-Respect for authority- Collective bargaining- Confidentiality-Role of

confidentiality in moral integrity- conflicts of interest-occupational crime-professional rights-employee right-IPR discrimination

Engineering Ethics & Professionalism- Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action- Self-Interest-Customs and Religion-uses of ethical theories.

Engineering as social Experimentation- Engineering as Experimentation-Engineers as responsible Experimenters- Codes of Ethics- Plagiarism-A balanced outlook on law- Challenger case study-Bhopal gas tragedy

Global Ethical Issues- Multinational Corporations- Environmental Ethics-Business Ethics- Computer Ethics- Role in Technological Development-Engineers as Managers-Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership

iv) a) TEXTBOOKS

1) Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, 1st Edition, 2016.
2) Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016
3) M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012
4) R S Naagarazan, A textbook on professional ethics and human values, New age international (P) limited, New Delhi,2006.

b) REFERENCES

1) Barun K. Mitra, Personality Development & Soft Skills, Oxford Publishers, 3rd impression, 2017.
2) Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2014.
3) Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
4) Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United states,2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Overview of Life Skills: Meaning and significance of life skills. Life skills identified by WHO: Self- awareness, Empathy, Decision making, problem solving, interpersonal relationship, coping with stress, coping with emotion. Self-awareness: Definition, need for self-awareness; Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests,	**5**

	feedback. Stress Management: Stress, reasons and effects, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion- oriented, acceptance- oriented, resilience, Gratitude Training, Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques	
II	Life skills for Professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, motivation, personality development, IQ, EQ, and SQ Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest-Occupational crime, Professional rights, Employee right, IPR, Discrimination	**5**
III	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry-Professionalism, Models of professional roles, Theories about right action-Self-Interest-Customs and Religion, Uses of Ethical Theories	**6**
IV	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law-Case study)	**8**
V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership-Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	**6**
	Total Hours	**30**

vi) ASSESSMENT PATTERN

Continuous Assessment: Group Project – 50 : 50

Continuous Assessment		
Attendance	:	5 marks
Case Study	:	30 marks
CAT	:	15 marks
(Test to be conducted for 30 marks and need to be converted to 15 Marks)		
Total Continuous Assessment	:	**50 marks**
Group Project with Presentation and Report	:	**50 marks**
TOTAL	:	**100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEP20A	ELECTRICAL NETWORKS LAB	MNC	0	0	2	0	1	2023

Pre-Requisite: 23ESL10J Basics of Electrical Engineering A

i) COURSE OVERVIEW:

The main objective of the course is to expose the students to have a hands-on experience to solve circuit using mesh and nodal analysis, applying different theorems and to solve a two port network. It also includes design and implementation of electrical circuits using PSpice.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply mesh and nodal analysis to experimentally verify circuit parameters	Apply
CO2	Apply basic circuit theorems to experimentally verify circuit parameters	Apply
CO3	Develop Z, Y, h and ABCD parameters of a two port network	Apply
CO4	Experimentally verify the response of series circuits	Apply
CO4	Apply simulation software to simulate electronic circuits.	Apply

iii) SYLLABUS

1. Verification of Kirchhoff's Voltage Law and Kirchhoff's Current Law
2. Verification of Mesh and nodal Analysis
3. Thevenin's and Maximum Power Transfer Theorem
4. Norton's and Reciprocity Theorem
5. Series and Parallel Resonance
6. Determination of Z Parameters of a two port network
7. Determination of Y Parameters of a two port network
8. Determination of Hybrid Parameters of a two port network
9. To determine the ABCD parameters of the cascade connection of a two-port network
10. Series R, RL and RLC circuit
11. Simulation of Mesh Analysis using PSpice Software
12. Simulation of Nodal Analysis using PSpice Software
13. Simulation of DC Transient Response of Series RL Circuit using PSpice Software
14. Simulation of DC Transient Response of Series RC Circuit using PSpice Software
15. Simulation of DC Transient Response of Series RLC Circuit using PSpice Software

iv) REFERENCES

1) Hayt and Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, New Delhi, 9th Edition, 2019.
2) Ravish R. Singh, “Network Analysis and Synthesis”, McGraw-Hill Education, 2013.
3) Sudhakar and Shyam Mohan, “Circuits and Networks: Analysis and Synthesis”, McGraw Hill Education, 5th Edition, 2015.
4) A. Chakrabarti, “Circuit Theory Analysis and Synthesis”, Dhanpat Rai & Co., 7th Revised Edition, 2018.

v) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
I	Verification of Kirchhoff’s Voltage Law and Kirchhoff’s Current Law	**2**
II	Verification of Mesh and nodal Analysis	**2**
III	Thevenin’s and Maximum Power Transfer Theorem	**2**
IV	Norton’s and Reciprocity Theorem	**2**
V	Series and Parallel Resonance	**2**
VI	Determination of Z Parameters of a two port network	**2**
VII	Determination of Y Parameters of a two port network	**2**
VIII	Determination of Hybrid Parameters of a two port network	**2**
IX	To determine the ABCD parameters of the cascade connection of a two-port network	**2**
X	Series R, RL and RLC circuit	**2**
XI	Simulation of Mesh Analysis using PSpice Software	**2**
XII	Simulation of Nodal Analysis using PSpice Software	**2**
XIII	Simulation of DC Transient Response of Series RL Circuit using PSpice Software	**2**
XIV	Simulation of DC Transient Response of Series RC Circuit using PSpice Software	**2**
XV	Simulation of DC Transient Response of Series RLC Circuit using PSpice Software	**2**
	Total Hours	**30**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 5 marks
Continuous Assessment	: 55 marks
Final Assessment	: 40 marks
Total	**: 100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEP20B	SIMULATION LAB	PCC	0	0	2	0	1	2023

i) COURSE OBJECTIVES

The main objective of the course is to expose the students to the simulation software PYSpice, Multisim, MATLAB and simulate basic electrical and electronics circuit using PYSpice (Python+Ngspice), Multisim and MATLAB softwares.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Model the basic circuits using PSpice	Apply
CO2	Develop the logic gates, half adder and full adder using Multisim	Apply
CO3	Develop the Boolean function and Combinational circuit using MultiSim	Apply
CO4	Model the basic electronic circuits using MATLAB Simulink	Apply

iii) LIST OF EXPERIMENTS

PYSPICE simulation of

i) DC Circuit Analysis with Dependent Sources
ii) Natural and Step Response of RC Circuits
iii) Pacemaker Circuit
iv) Digital Logic Gates

MultiSim simulation of

i) Verification of Truth Tables of Logic Gates
ii) Half Adder and Full Adder Circuit
iii) Boolean Function in SOP and POS Form
iv) Combinational circuit using minimum number of NAND Gates

MATLAB simulation of

i) Switching characteristics of Diode
ii) Zener diode as voltage regulator
iii) Half wave Rectifier
iv) Full wave Rectifier

iv) REFERENCES

1) James Squire, Anthony English, Introduction to Python and Spice for Electrical and Computer Engineers, Elsevier Science,2024.
2) Won Y. Yang, Seung C. Lee, Circuit Systems with MATLAB and PSpice, Wiley 2008.
3) Paul Tobin., *PSpice for Circuit Theory and Electronic Devices*, Morgan & Claypool Publishers, 2007.
4) John Okyere Attia, PSPICE and MATLAB for Electronics An Integrated Approach, second edition, CRC Press,2010
5) John Reeder, Using MultiSIM Digital Electronics, Delmar,2002
6) James Nilsson, Susan Riedel, Introduction to Multisim for Electric Circuits, Pearson, 2018.

v) COURSE PLAN

Expt. No.	Contents	No. of hours
1	Simulation of DC Circuit with Dependent Sources using PYSpice	**2**
2	Simulation of Natural and Step Response of RC Circuits using PSpice	**2**
3	Simulation of Pace maker circuit using PYSpice	**2**
4	Simulation of Logic Gates using PYSpice	**2**
5	Verification of Truth Tables of Logic Gates using MultiSim	**2**
6	Implementation of Half Adder and Full Adder Circuit in MultiSim	**2**
7	Implementation of Boolean Function in SOP and POS Form in MultiSim	**2**
8	Implementation of Combinational circuit using minimum number of NAND Gates	**2**
9	Simulation on Switching characteristics of Diode using MATLAB	**2**
10	Implementation of Zener diode as voltage regulator in MATLAB	**2**
11	Implementation of Half wave Rectifier using MATLAB	**2**
12	Implementation of Full wave Rectifier using MATLAB	**2**
	Total Hours	**30**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 5 marks
Continuous Assessment	: 55 marks
Final Assessment	: 40 marks
Total	**: 100 marks**

B.TECH S3 MINORS

Basket	Course Code	Course Name	L-T-P-J	Credits
I	23EEL2MA	Microcontrollers and Embedded Systems	3-0-0-0	3
II	23EEL2MC	Basics of Illumination Science and Lighting Design	3-0-0-0	3
III	23EEL2ME	Sustainable Energy Systems	3-0-0-0	3
IV	23EEL2MG	Electric Machinery	3-0-0-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MA	MICROCONTROLLERS AND EMBEDDED SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The aim of this course is to introduce embedded C programs. Students will be familiarized with 8051 microcontroller and will get an overview of what an embedded system is. This course also provides a brief introduction to various open-source prototyping platforms.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the concepts of an Embedded system.	Understand
CO2	Compare Microcontroller with a Microprocessor and explain the architecture of 8051.	Understand
CO3	Develop 8051 Embedded C programs for Data Operations and Timer/Counter.	Apply
CO4	Develop 8051 Embedded C programs for Serial Communication and Interfacing.	Apply
CO5	Explain different Open-Source Prototyping platforms.	Understand

iii) SYLLABUS

Overview of Embedded Systems: Characteristics, Architecture, Categories, Design process, Challenges, Trends.

Introduction to Microprocessor and Microcontrollers, 8051 architecture.

8051 programming in C – I/O programming, programming on Data Conversions, Timer/Counter programs, 8051 embedded c serial communication programs, Interfacing of ADC, DAC, LCD, DC motor.

Introduction to different open-source prototyping platform - Arduino, Raspberry Pi, Galileo.

iv) (a) TEXT BOOKS

1) Mohammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson, 2nd Edition,2007.
2) Kenneth J. Ayala, The 8051 Microcontroller Architecture, Programming and Application, Cengage Learning, 3rd Edition,2012.
3) Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Pearson Education, 2nd Edition, 2012.

(b) REFERENCES

1) Shibu K. V., "Introduction to Embedded Systems", 2nd Edition, McGraw Hill Education India, 2016.
2) Uday Shankar V., Mallikarjun Swamy, "The 8051 Microcontroller", McGraw Hill, 2009.
3) Dr. Uma Rao K., Dr. Andhe Pallavi, "The 8051 Microcontroller", Sanguine, 2009.
4) Steve Heath, "Embedded Systems Design", Newnes, 2nd Edition, 2002.
5) Simon Monk, "Programming Arduino: Getting started with sketches", Mc Graw Hill, 2nd Edition, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Embedded System**: Definition, Application areas, Design of embedded systems, Recent trends and challenges in embedded systems. Introduction to embedded microcontroller cores.	**8**
II	**Microprocessors and microcontroller-** Introduction, Microprocessors and Microcontrollers, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture. 8051 Architecture, Memory organization, External memory interfacing, Stack.	**8**
III	**8051 Programming in C:** Data types and time delays in 8051C, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization. **Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter Programming, programming timers 0 and 1in 8051C.	**10**
IV	**8051 Serial Communication:** Basics of Serial Communication, 8051 connections to RS-232, 8051 Serial communication Programming, Programming the second serial port, Serial port programming in C. **8051 Interfacing and Applications:** Interfacing 8051 to LCD, Keyboard, parallel and serial ADC, DAC, Stepper motor interfacing, DC motor interfacing and PWM.	**11**
V	**Introduction to Open-source prototyping platforms**: Arduino, Raspberry Pi, ARM Cortex, Intel Galileo, Basic Arduino programming; Raspberry pi; Intel Galileo boards	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MC	BASICS OF ILLUMINATION SCIENCE AND LIGHTING DESIGN	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The main goal of this course is to introduce basics of illumination technology and lighting design aspects to students. Also enable them to understand lighting design considerations for interior and exterior applications. This course will impart knowledge about energy efficient lighting and get detailed insight of indoor and outdoor illumination system components and its controls.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Compare different types of lighting schemes; different artificial light sources.	Understand
CO2	Apply Laws of Illumination to calculate the illuminance level at a point.	Apply
CO3	Choose lamps and luminaires for specific applications.	Apply
CO4	Design interior and exterior lighting systems.	Apply
CO5	Choose suitable control methods for lighting and demonstrate various features of aesthetic lighting.	Apply

iii) SYLLABUS

Light, sight & colour - Sources of light - Methods of artificial lighting - Lighting schemes - Lighting systems - Quality of lighting - Good Practices in Lighting.

Measurement of light - Lamp efficiency - Concept of polar curve - Laws of illumination - Lighting calculations - Photometric data sheets - National Lighting Code 2010.

The balance of lighting in indoor and outdoor workplaces – Daylight - Task lighting - Glare - Specular reflection - Sunlight shading - Light sources - Introduction to LED Lighting.

Design of Interior and Outdoor lighting- Indian Standards - Selection of appropriate lamps - Calculation and Layout of luminaires.

Features of Interior Lighting - Lighting Control - Daylight sensors and occupancy sensors - Features of Aesthetic Lighting - Computer Aided Lighting design.

iv) (a) TEXT BOOKS

1) D.C. Pritchard, “Lighting”, Routledge, 6th Edition, 2014.
2) Jack L. Lindsey, FIES, Scott C. Dunning, “Applied Illumination Engineering”, Fairmont Press, 3rd Edition, 2015.

(b) REFERENCES

1) M. K. Giridharan, “Electrical Systems Design”, I K International Publishers, New Delhi, 2nd Edition, 2016.
2) Rüdiger Ganslandt, Harald Hofmann, “Handbook of Lighting”, ErCOEdition, 1997.

3) John Matthews, "Introduction to the Design and Analysis of Building Electrical Systems", Springer, 1993.
4) "SLL Lighting Handbook", CIBSE, 2018.
5) M.A. Cayless, "Lamps and Lighting", Routledge, 1996.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Light, sight and colour:** Sources of light - Day light, artificial light sources - energy radiation, visible spectrum of radiation. Incandescence, dependence of light output on temperature. Perception of light and colour - optical system of human eye - eye as visual processor. Quality of lighting- visual comfort, visual performance, safety, shadow, glare, reflection, colour rendering, colour appearance and stroboscopic effect **Methods of artificial lighting:** Lighting systems- direct, indirect, semi direct, semi-indirect, Lighting schemes-ambient, task, accent lighting. General and localized - Artificial lighting as substitute to natural light. Good Practices in Lighting.	**8**
II	**Measurement of light:** Luminous flux, Luminous intensity, Lumen, Illuminance, Luminance, Candle power- M.H.C.P, M.S.C.P - Lamp efficiency. Concept of polar curve - Laws of illumination - Inverse square law and Lambert's Cosine law. Lighting calculations- Point by point method and Average Lumen method. Photometric data sheets- Finding Lux using Lux meters - Indian standard recommendation and standard practices for illumination levels in various areas – National Lighting Code 2010.	**8**
III	**Balance of lighting in indoor and outdoor workplaces:** Daylight- Room brightness- Task lighting - Glare - Specular reflection - Balance of daylight and electrical light- Colour appearance of lamps - Sunlight shading. **Light sources:** Different types of lamps and its evolution - Incandescent lamp - Fluorescent Lamp, Compact Fluorescent Lamp (CFL). Sodium Vapour lamp, Metal halide Lamps, Argon Neon lamps for signboards. Introduction to LED Lighting.	**10**
IV	**Design of Interior Lighting:** Interior Lighting Design Standards - Maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it - Illumination required for various work planes, Space to mounting height ratio (SHR) - DLOR and ULOR - Selection of lamp and luminance - Selection of utilisation factor, reflection factor and maintenance factor - Calculation of wattage of each lamp and no of lamps needed - Layout of luminaires. **Design of Outdoor Lighting:** Street Lighting design- Flood lighting- Beam angle- Selection of lamp and projector	**10**

V	**Special features of Interior Lighting:** Entrance, corridors, industrial buildings. Introduction to Lighting Controls - Methods of control, Selection of Lighting Controls - Dimmers for various lamps - Daylight sensors and occupancy sensors. **Special Features of Aesthetic Lighting:** Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting, Facade Lighting, Retail Lighting. **Computer Aided Lighting design:** Role of computers in design - Softwares used for lighting design.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2ME	SUSTAINABLE ENERGY SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The aim of this course is to introduce the students about current and potential future energy systems, extraction, conversion and applications, with emphasis on meeting regional and global energy needs in a sustainable manner and also have an increased awareness on issues in the areas of sustainability.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the concept and need of sustainability.	Understand
CO2	Explain the classification of energy sources, potentials, achievements and applications.	Understand
CO3	Illustrate production of energy from solar and wind.	Understand
CO4	Discuss energy sources like biomass, tides, ocean, geothermal and hydro.	Understand
CO5	Explain the concept of various types of energy storage systems.	Understand

iii) SYLLABUS

Energy Fundamentals- Sustainability, Need and concept of sustainability, Social, environmental and economic sustainability concepts.

General classification of energy- Conventional and non-conventional, Global and Indian energy sources.

Solar and Wind Energy- Applications- Merits and demerits-Global uptake and future possibilities of solar and wind energy.

Production of ocean, geothermal and hydro energy –Energy conversion- Global and Indian scenario- Global uptake and future possibilities of ocean, geothermal and hydro energy.

Energy production from biomass and wastes-Biomass resources- Biomass conversion technologies- Fuel cells- types and applications.

Energy Storage and Conservation - Characteristics and uses of Energy Storage System-Energy Conservation Methods-Case Studies.

iv) (a) TEXT BOOKS

1) Boyle, Godfrey, “Renewable Energy”, 3rd Edition, Oxford University Press, 2012.
2) Bansal N. K., Kleemann M., Michael Meliss, “Renewable Energy Sources & Conversion Technology”, Tata McGraw Hill publishing Company, New Delhi 1990.
3) Rai G. D., “Non-conventional Energy Sources”, Khanna Publishers, 2011.

(b) REFERENCES

1) Gary L. Johnson, “Wind Energy System”, Prentice Hall Inc, 1995.
2) Earnest J., Wizelius T., “Wind Power Plants and Project Development”, PHI Learning Pvt Ltd, 2nd Edition, 2015.

3) Rai G. D., "Solar Energy Utilization", Khanna Publishers, 1995.
4) Sayigh A. A. M., "Solar Energy Engineering", Academic Press, 1977.
5) Abbasi S. A., Abbasi N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, 2001.
6) Khan B. H., "Non-Conventional Energy Resources", Tata McGraw Hill, 2009.
7) Sawhney G. S., "Non-Conventional Energy Resources", PHI Learning, 2012.
8) Allen D. T., Shonnard D. R., "Sustainability Engineering: Concepts, Design and Case Studies", Pearson; Illustrated Edition, 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction and Energy Fundamentals**- Sustainability, Need and concept of sustainability, Social, environmental and economic sustainability concepts, Sustainable development, Challenges for sustainable development-Increasing energy demand and climate change **General classification of energy**- Conventional and non-conventional, Global and Indian energy sources, Environmental aspects of energy utilization, Energy planning, Renewable energy sources, potentials, achievements and applications	**8**
II	**Solar Energy**- Solar radiation, Solar thermal systems-Flat plate and concentrating collectors, Solar desalination, Solar pond, Solar dryers, Solar cookers, Solar thermal electric power plant, Solar photovoltaic conversion, Merits and limitations of solar energy **Wind Energy** – Availability of wind energy, Site characteristics, Wind turbine types, Wind power plants, Merits and limitations of wind energy Carbon footprint, global uptake and future possibilities for solar and wind energy	**8**
III	**Production of ocean, geothermal and hydro energy**-Ocean thermal electrical conversion, Tidal energy conversion Geothermal energy conversion -Hydropower-Global and Indian scenario - Positive and negative attributes of hydropower-Electricity from hydropower - Small hydroplants. Carbon footprint, global uptake and future possibilities for ocean, geothermal and hydropower.	**10**
IV	**Energy production from biomass and wastes**-Biomass resources, Biomass conversion technologies- direct combustion, pyrolysis, biomass gasification, Biogas production, Bioethanol, Biodiesel, Hydrogen as fuel, Biohydrogen production, Storage of hydrogen, Carbon footprint, global uptake and future possibilities for bioenergy. **Fuel cells**-types and applications.	**9**
V	**Energy Storage and Conservation** - Characteristics & uses of Energy Storage System- Flywheel storage, Compressed air storage, Battery Storage, Pumped Hydro Energy Storage-Energy Conservation Methods **Case Studies** – Sustainability assessment of conventional energy systems, Sustainability assessment of alternative energy systems.	**10**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MG	ELECTRIC MACHINERY	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of DC machines, transformers, induction motors and synchronous machines including constructional details, principle of operation, performance and applications. It introduces students to cognitive learning and develops problem solving skills.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the principle of operation and characteristics of DC machines.	Understand
CO2	Apply emf equation and power flow equations to solve problems based on DC Machines.	Apply
CO3	Develop the phasor diagram and equivalent circuit of a transformer, and to calculate its losses and efficiency.	Apply
CO4	Explain the principle of operation and types of three phase and single-phase Induction motors.	Understand
CO5	Illustrate the principle of operation of alternators and synchronous motors and to compute regulation of alternators.	Understand

iii) SYLLABUS

DC generators: principle of operation -emf equation-types of excitations- armature reaction, OCC.

Principle of operation of DC motors - torque and speed equations- characteristics- applications of DC shunt, series and compound motors - starters - losses and efficiency – load test.

Transformers – principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - maximum efficiency – all day efficiency – auto transformers.

Three phase induction motors- types - principle of operation – torque slip characteristics- no load and blocked rotor tests - Circle diagram - methods of starting.

Single phase Induction motor- principle of operation - resistance split phase motor – capacitor start motor.

Synchronous machines: construction– emf equation of alternator – regulation of alternator by emf method - synchronous motors- methods of starting- V curves, synchronous condenser.

iv) (a) TEXT BOOKS

1) Bhimbra P. S., “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.
2) Kothari D. P. and I. J. Nagrath, “Electrical Machines”, Tata McGraw Hill, 2004.
3) Fitzgerald A. E., Kingsley C. and Umans S., “Electric Machinery”, McGraw Hill, 6th Edition, 2003.

4) Mehta V. K. and R. Mehta, “Principles of Electrical and Electronics”, S. Chand & Company Ltd., 1996.

(b) REFERENCES

1) Gupta J. B., Theory and Performance of Electrical Machines, S K Kataria & Sons, 14th Edition, 2013.
2) Deshpande M. V., “Electrical Machines”, Prentice Hall India, New Delhi, Eastern Economy Edition, 2011.
3) Theraja B. L. and A. K. Theraja, “A Text Book of Electrical Technology”, S. Chand & Company Ltd., 2008.
4) S.K. Bhattacharya, “Electrical Machines”, Tata McGraw-Hill Publishing Company Limited, New Delhi.

v) COURSE PLAN

Module	Contents	No. of hours
I	**DC generators**: Principle of operation -emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. Concept of armature reaction-OCC and load characteristics- Power flow diagram - simple numerical problems.	**8**
II	**DC motors:** Principle of operation-torque and speed equations-characteristics of DC motors- applications of DC shunt, series and compound motors - concept of starters - Power flow diagram – losses and efficiency– load test- simple numerical problems.	**8**
III	**Transformers**: principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - maximum efficiency –regulation- all day efficiency - simple numerical problems- auto transformers.	**8**
IV	**Three phase induction motors**: slip ring and squirrel cage types - principle of operation – rotating magnetic field- power and torque equations - torque slip characteristics - no load and blocked rotor tests - Equivalent Circuit - Circle diagram - methods of starting – star-delta starting, auto transformer starting, rotor resistance starting.	**10**
V	**Single phase Induction motor**: principle of operation of single-phase induction motors – double field revolving theory- types - resistance split phase motor – capacitor start motor- capacitor start run motor. **Synchronous machines**: construction– emf equation of alternator –phasor diagram under lagging power factor - regulation of alternator by emf method. Principle of operation of synchronous motors- methods of starting- V curves, synchronous condenser.	**11**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

SEMESTER IV

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MAL20D	PROBABILITY, STATISTICS AND NUMERICAL METHODS	BSC	3	1	0	0	4	2023

i) COURSE OVERVIEW

This course introduces students to the modern theory of probability and statistics, covering important models of random variables and techniques of parameter estimation and hypothesis testing. A brief course in numerical methods familiarizes students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations, and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Identify the different discrete random experiments and find the probabilities of their occurrence	Apply
CO2	Identify the different continuous random experiments and find the probabilities of their occurrence	Apply
CO3	Use statistical inference to draw conclusions concerning characteristics of a population based on attributes of samples drawn from the population	Apply
CO4	Find roots of equations, definite integrals and interpolating polynomial on given numerical data using standard numerical techniques	Apply
CO5	Apply standard numerical techniques for solving systems of equations, ordinary differential equations and for fitting curves on given numerical data	Apply

iii) SYLLABUS

Discrete random variables and their probability distributions, Binomial distribution, Poisson distribution, Discrete bivariate distributions, Expectation -multiple random variables.

Continuous random variables and their probability distributions -Uniform, exponential and normal distributions, Continuous bivariate distributions, Expectation-multiple random variables, i.i.d random variables and Central limit theorem.

Population and samples, Sampling distribution of the mean and proportion. Test of hypotheses Concerning mean and proportion. Confidence interval.
Roots of equations- Newton-Raphson, regula falsi methods. Interpolation-finite differences, Newton’s forward and backward formula, Newton’s divided difference method, Lagrange’s method. Numerical integration.’’’

,,

Solution of linear Systems-Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, Solution of ordinary differential equations -Euler and Classical Runge-Kutta method of second and fourth order, Adams- Moulton predictor-correction method

iv) a) TEXTBOOKS

1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage, 2012
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley & Sons, 2016.

b) REFERENCES

1) Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2) Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
3) T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
4) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Discrete random variables and probability distributions, expected value, mean and variance (discrete) Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial-Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	**12**
II	Continuous random variables and probability distributions, expected value, mean and variance (continuous)-Uniform, exponential and normal distributions, mean and variance of these distributions Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	**12**
III	Population and samples, Sampling distribution of single mean and single proportion (large samples) Confidence interval for single mean and single proportions (large samples) Hypothesis testing basics, large sample test for single mean and single proportion Large sample test for equality of means and equality of proportions of two populations-t-distribution and small sample t-test for single mean and pooled t-test for equality of means	**12**

IV	Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula- Falsi method. Interpolation-finite differences, Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	**12**
V	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares -Solution of ODE-Euler and Classical Runge Kutta methods of second and fourth order- Adams-Moulton predictor- corrector methods	**12**
	Total Hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL20D	ELECTRONIC DEVICES AND CIRCUITS	PCC	3	1	0	0	4	2023

Pre-Requisite: 23ESL10L Basics of Electronics Engineering

i) COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental concepts of solid-state devices and linear integrated circuits. This course introduces the various concepts and design of oscillators, feedback amplifiers, and multivibrators.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the various wave shaping circuits using diodes and biasing circuits for BJT.	Understand
CO2	Model BJT and FET amplifier circuits.	Apply
CO3	Explain the various multistage, power and feedback amplifiers	Understand
CO4	Develop waveform generating circuits using BJT, Op Amp and 555 timer IC.	Apply
CO5	Identify Op-Amp circuits for various applications.	Apply

iii) SYLLABUS

Diode clipping circuits, Clamping circuits, Design of Zener Voltage Regulators.
Review of BJT characteristics, Operating point of a BJT – DC load line and Q point, Biasing circuits, Bias compensation. BJT Amplifier - Common Emitter amplifier- h parameter model.
JFET and MOSFET construction - working and characteristics. JFET Amplifiers - small signal model and analysis of CS amplifiers, Frequency response of Amplifiers.
Multistage amplifiers - Gain of Multistage amplifiers, Types, Power amplifiers using BJT, Feedback Amplifiers - Basic feedback topologies. Oscillators – RC oscillators and LC oscillators.
Operational Amplifiers - Analysis of fundamental differential Amplifier, Op-Amp Parameters, Inverting and Non-Inverting Amplifiers, Open loop and Closed loop Configurations, Concept of virtual short. OP-AMP Circuits, Waveform generation using Op-Amps. Timer 555 IC - Internal diagram of 555 IC, Astable and Mono-stable multivibrators using 555 IC.

iv) (a) TEXT BOOKS

1) Boylestad R. L. and Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, 10th Edition, 2009.
2) Millman J. and Halkias C. C., "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2nd Edition, 2010.

3) Roy D. C. and Jain S. B., "Linear Integrated Circuits", New Age International, 3rd Edition, 2010.

(b) REFERENCES

1) Bernard Etkin, Dyn Floyd T. L., "Fundamentals of Analog Circuits", Pearson Education, 2nd Edition, 2012.
2) Robert Paynter T. and John Clemons, "Paynter's Introductory Electronic Devices & Circuits", Prentice Hall Career & Technology, 3rd Edition, 1994.
3) Bell D. A., "Electronic Devices and Circuits", Prentice Hall of India, 2007.
4) Streetman B. G. and Banerjee S., "Solid State Electronic Devices", Pearson Education Asia, 2006.
5) Gayakward R. A., "Op-Amps and Linear Integrated Circuits", PHI Learning Pvt. Ltd., 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Diode Circuits:** Diode Clipping and Clamping circuits. **Bipolar Junction Transistors:** Review of BJT characteristics- Operating point of BJT – Factors affecting stability of Q point. DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilization. Stability factor (Derivation of stability factors for Voltage Divider Biasing only). Numerical problems. Bias compensation using diode and thermistor. **BJT Model** - h-parameter model of BJT in CE configuration. Small signal low frequency ac equivalent circuit of CE amplifier –Role of coupling capacitors and emitter bypass capacitor. Calculation of amplifier gains and impedances using h parameter equivalent circuit.	**13**
II	**Field Effect Transistors:** Review of JFET and MOSFET (enhancement mode only) construction, working and characteristics - JFET common source amplifier. **Frequency response of Amplifiers:** Internal Capacitances at high frequency operations of BJT- Low and high frequency response of Common Emitter amplifier. Frequency response of CE amplifier, Gain bandwidth product.	**12**
III	**Multistage amplifiers:** Direct, RC, transformer coupled Amplifiers, Applications. **Power amplifiers using BJT:** Class A, Class B, Class AB, Class C and Class D. Conversion efficiency – derivation (Class A and Class B). Distortion in power amplifiers. **Feedback in Amplifiers**-Effect of positive and negative feedback. **Oscillators:** Barkhausen Criterion – RC oscillators (RC Phase shift oscillator and Wein Bridge oscillator) – LC oscillators (Hartley and Colpitt's) – Derivation of frequency of oscillation - Crystal oscillator.	**12**

IV	**Operational Amplifiers:** Fundamental differential amplifier - Modes of operation. Properties of ideal and practical Op-amp - Gain, CMRR and Slew rate. Parameters of a typical Op-amp IC 741. Open loop and Closed loop Configurations-Concept of virtual short. Negative feedback in Op-amps. Inverting and non- inverting amplifier circuits. Summing and difference amplifiers, Instrumentation amplifier.	**11**
V	**OP- AMP Circuits:** Differentiator and Integrator circuits-practical circuits – Design –Comparators: Zero crossing and voltage level detectors, Schmitt trigger. **Waveform generation using Op-Amps:** Square, triangular and ramp generator circuits using Op-Amp- Effect of slew rate on waveform generation. **Timer 555 IC:** Internal diagram of 555 IC – Astable and Monostable multi-vibrators using 555 IC.	**12**
	Total hours	**60**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL20E	DC MACHINES AND TRANSFORMERS	PCC	2	1	0	0	3	2023

i) COURSE OVERVIEW: This course provides an introduction to the basic concepts of DC Machines, transformers and their testing methods, emphasizing their inter-relations and applications to engineering. The course also intends to deliver the benefits of auto transformers and types of three phase connections. It introduces students to cognitive learning and develops problem solving skills.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the construction, principle of operation and types of DC Machines.	Understand
CO2	Solve problems based on the performance characteristics, speed control and braking techniques of DC Motors.	Apply
CO3	Apply emf equation, power flow and torque equations to solve problems based on DC machines.	Apply
CO4	Develop the phasor diagram and equivalent circuit of a transformer and solve problems based on transformer operation and testing.	Apply
CO5	Explain the basic principle of autotransformers, and other types of transformer connections.	Understand

iii) SYLLABUS

Introduction to DC Machines-Construction, Types of windings, EMF, MMF, Electromagnetic Torque.

DC Generators – Principle - EMF equation - Armature reaction, compensating windings, interpoles – commutation - methods to improve commutation, Characteristics, Power Flow Diagram, Applications.

DC Motors – principle of operation – torque equation – losses and efficiency – power flow diagram – performance characteristics– methods of speed control – No load and load tests on DC motors - applications.

Transformers – principle of operation – types and construction –ideal transformer - equivalent circuit – phasor diagram, Transformer losses and efficiency - voltage regulation - Autotransformers - Three phase transformer connection.

iv) (a) TEXT BOOKS

1) Bimbra P. S., “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.
2) Fitzgerald A. E., Kingsley C. and Umans S., “Electric Machinery”, McGraw Hill, 6th Edition, 2003.
3) Theodore Wilde, “Electrical Machines, Drives and Power System”, Pearson Ed. Asia, 6th Edition, 2013.
4) Kothari D. P., Nagrath I. J., “Electric Machines”, Tata McGraw Hill, 5th Edition,2010.

(b) REFERENCES

1) Gupta J. B., “Theory and Performance of Electrical Machines”, S K Kataria & Sons, 14th Edition, 2013.

2) Deshpande M. V., "Electrical Machines", Prentice Hall India, New Delhi, Eastern Economy Edition, 2011.
3) Ashfaq Husain, Haroon Ashfaq, "Electric Machines", Dhanpat Rai and Co., 3rd Edition,2016.
4) Clayton A. E. and Hancock N. N., "The Performance and Design of Direct Current Machines", CBS Publishers & Distributors, New Delhi, 3rd Edition, 2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to DC Machines** - Construction details of dc machines - armature winding - single layer winding, double layer windings - lap and wave, equalizer rings, dummy coils, EMF developed, numerical problems.	**8**
II	**DC Generators** – principle of operation, EMF equation, types, armature reaction – demagnetizing and cross magnetizing ampere turns, compensating windings, inter-poles, commutation, OCC, voltage build up and load characteristics, parallel operation. Power flow diagram – numerical problems.	**9**
III	**DC Motors** - Back EMF, generation of torque, torque equation, performance characteristics – numerical problems, Starting of dc motors - starters – 3 point and 4-point starters (principle only), Speed control of dc motors - field control, armature control. Braking of dc motors. Power flow diagram – losses and efficiency. Testing of dc motors - Swinburne's test. DC motor applications – numerical problems.	**10**
IV	**Transformers** - Single phase transformers–constructional details, principle of operation, EMF equation, ideal transformer, magnetizing current, transformation ratio, phasor diagram at lagging pf, equivalent circuit, percentage and per unit impedance, voltage regulation. Transformer losses and efficiency, condition for maximum efficiency, kVA rating, Testing of transformers– polarity test, open circuit test, short circuit test, Sumpner's test – separation of losses, all day efficiency. Parallel operation of single-phase transformers– numerical problems.	**10**
V	**Autotransformer** – Autotransformer – saving of copper –rating of autotransformers. **Three phase transformer** – advantages- difference between power transformer and Distribution transformer –Different connections of 3-phase transformers - Y-Y, Δ-Δ, Y-Δ, Δ-Y, V-V. Vector groupings – Yy0, Dd0, Yd1, Yd11, Dy1, Dy11, Three winding transformer, Tap changing transformers- no load tap changing, on load tap changing, dry type transformers.	**8**
	Total hours	**45**

ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEB20F	MICROCONTROLLER AND APPLICATIONS	PCC	3	1	2	0	5	2023

i) COURSE OVERVIEW: This course is designed to introduce microcontroller assembly language programming. Students will be taught the basic use of an assembly as well as embedded C programming environment to control peripheral devices. Students will also understand the interfacing of various peripheral elements with microcontroller to design an automated system. The course prepares the student with a set of concepts common to many different embedded systems.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the architecture of a microcontroller-based system.	Understand
CO2	Develop assembly language and embedded C program for 8051 microcontrollers.	Apply
CO3	Develop Assembly and Embedded C program for serial port communication and time delay using timers/counters of 8051.	Apply
CO4	Develop embedded C Interrupt programs and to interface various peripheral devices with 8051 microcontrollers	Apply
CO5	Implement a real time application	Apply

iii) SYLLABUS

Architecture of Intel 8051 Microcontrollers, Assembly programming for 8051 microcontrollers, Embedded C programs for I/O port, serial port communication, timer/counter, Interrupt programming, interfacing external peripherals.

Advanced Processors and Concepts, Vega Board Processors

iv) (a) TEXT BOOKS

1) Muhammad Ali Maidu and Janice Gillespie, “The 8051 Microcontroller and Embedded Systems – using assembly and C”, Pearson, 2nd Edition 2007.
2) Kenneth J. Ayala, “The 8051 Microcontroller”, 3rd Edition, Thomson/Cengage Learning, 2007.
3) Han Way Huang, “Using the MCS-51 family”, Oxford University Press, 2000.
4) Craig Steiner, “Microcontroller: Architecture Assembly”, WP Publishers / Microsoft Press, 2007.

(b) REFERENCES

1) Ramesh Gaonkar, “Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)”, January 2010.
2) Manish K Patel, “The 8051 Microcontroller Based Embedded Systems”, McGraw Hill, 2017, ISBN: 978-93-329-0125-4.
3) Raj Kamal, “Microcontrollers: Architecture, Programming, Interfacing and System Design”, Pearson Education, 2011.

4) K.Uma Rao & Andhe Pallavi, "The 8051 microcontrollers, architecture and programming and applications", Pearson, 2010.
5) Ajay V. Deshmukh, "Microcontrollers and application", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
6) D. Karuna Sagar, "Microcontroller", Alpha Science International Ltd., 2010-12.

v) COURSE PLAN

Module	Contents	No. of hours
I	Fundamentals of Microprocessors and Microcontrollers. Architecture of Intel 8051 microcontroller, 8051 Register Banks and Stack, Internal Memory Organization of 8051, Types of Special Function Registers and their uses in 8051.	**7**
II	Introduction to 8051 assembly programming- Instruction sets, Addressing modes, Assembler directives, Assembly Programs – Bit handling, Arithmetic and Logical operations, Data conversion, Sorting.Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in 8051 C, Data conversion program in 8051 C.	**10**
	Laboratory Experiments: 8051 ALP for Data transfer: Block data movement, exchanging data. Arithmetic and Logic Operations, sorting, finding the largest element in an array. 8051 C Program for Data Conversions, Bit manipulation, Arithmetic and Logical Operations	**8**
III	Programming 8051 timers and Counter – Mode 1 and Mode 2 Timer and Counter Programming in Assembly and Embedded C Basics of serial communication, 8051 connections to RS232, serial port programming in Assembly and 8051 C.	**10**
	Laboratory Experiments: Timer/Counter Implementation in Keil software, Serial Port Programming in Keil software	**4**
IV	Interrupt programming in 8051 C- Timer Interrupts, External Interrupts, Interrupt priorities, Serial Communication Interrupt. Interfacing LCD, seven segment display, DIP switches, ADC, DAC, Stepper motor, DC motor.	**8**
	Laboratory Experiments: Interfacing LCD, ADC, Stepper motor, DAC using Keil and Proteus software	**18**
V	Introduction to Advanced Processors and Concepts- RISC and CISC processors, ARM architecture, ARM Instructions- Vega Processor – Programming Case study.	**8**
	Laboratory Experiments: Familiarization of Advanced Processors	**2**
	Total hours	**75**

Sl.No	Laboratory Program/Experiment	No of Hours
1	Data transfer: Block data movement, exchanging data.	2
2	Sorting- Ascending/Descending, Finding the largest / smallest element from an array of numbers	2
3	Code conversions – Hex to Decimal/ASCII to Decimal and vice versa,	2
4	8051 C programs for bit manipulation, Arithmetic and Logical Operations	2
5	Timer/Counter Implementation	2
6	Serial Port Programming	2
7	Interrupt Programming	2
8	Display Interface	4
9	Analog Sensors , ADC Interface	4
10	DAC Interface	4
11	Stepper motor and DC motor Interface	4
	Total	**30**

vi) ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	5 marks
Assignment / Project Work	:	15 marks
Assessment through Tests	:	20 marks
Assessment of Lab Work	:	10 marks
Lab Exam	:	10 marks
Total Continuous Assessment	**:**	**60 marks**
End Semester Examination	**:**	**40 marks**
TOTAL	**:**	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules (approx.)

END SEMESTER EXAMINATION

Maximum Marks: 40

Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23HSL2NB	UNIVERSAL HUMAN VALUES-II	HSC	2	1	0	0	1	2023

i) COURSE OVERVIEW:

The objectives of the course are:

(i) To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS'
(ii) To facilitate the development of a holistic perspective among students towards life and profession leading towards a value-based living
(iii) To help the students to have ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with nature.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Understand themselves and their surroundings (family, society, nature)	Understand
CO2	Show more commitment towards what they have learnt about Human values, Human relationship and Human society	Understand
CO3	Apply Sustainable Solutions to Real Life problems based on the learning gained through Universal Human Values	Apply

iii) SYLLABUS

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course, recapitulation from Universal Human Values-I

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

(Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking)

Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding thecharacteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

(Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs. dealing with disease)

Understanding Harmony in the Family and Society- Harmony in Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

(Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives)

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence,

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all pervasive space Holistic perception of harmony at all levels of existence.

(Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.)

Implications of the above Holistic Understanding of Harmony on Professional Ethics, Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,

c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems Strategy for transition from the present state to Universal Human Order

a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers.

b. At the level of society: as mutually enriching institutions and organizations Sum up.

(Include practice Exercise and Case studies will be taken up in Practice (tutorial) Sessions. Eg. To discuss the conduct as an engineer or scientist etc.)

iv) (a) TEXT BOOKS

1) Gaur P.R, Asthana R, Bagaria G.P, Human Values and Professional Ethics (2ndrevised Edition) Excel Books, New Delhi, 2019
2) Tripathi A. N, Human Values, New Age Intl. Publishers, New Delhi, 2004.

(b) REFERENCES

1) Gaur R.R, Sangal R, Bagaria G P 'A Foundation Course in Human Values and Professional Ethics (Teacher Manual), Excel Books, 1stEdition 2013.
2) Parichaya E K, Nagaraj A,Jeevan Vidya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3) Mohandas K Gandhi, 'The story of my Experiments with Truth' Fingerprint,2009
4) Cecile Andrews 'Slow is Beautiful',New Society Publishers,2006.
5) Kumarappa J C Economy of Permanence, Sarva Seva Sangh Prakashan, 2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	Understanding Value Education Self-Exploration as the process for Value Education Sharing about oneself Understanding Happiness and Prosperity-the Basic Human Aspirations Right Understanding, Relationship, Physical Facility Exploring Human Consciousness Happiness and Prosperity- Current Scenario Method to Fulfil the Basic Human Aspirations Exploring Natural Acceptance	**9**
II	Understanding Human Being as the Co-existence of the Self and Body Distinguishing between the needs of the Self and the Body Exploring the difference of needs of the Self and the Body, The Body as an Instrument of the Self Understanding Harmony in the Self-Exploring Sources of Imagination in the Self-Harmony of the Self with the Body Programme to ensure Self-Regulation and Health Exploring Harmony of Self with the Body	**9**
III	Harmony in the Family-the Basic unit of Human Interaction Values in the Human-to-Human Relationship 'Trust' –the foundation Value in Relationship Exploring the feeling of Trust 'Respect'- as the Right Evaluation Exploring the feeling of Respect Understanding Harmony in the Society Vision for the Universal Human Order Exploring Systems to fulfil Human Goal	**9**
IV	Understanding Harmony in the Nature Interconnectedness, self regulation and Mutual Fulfilment among the four orders of Nature Exploring the four orders of Nature Realizing Existence as Co-Existence at all Levels The Holistic Perception of Harmony in Existence Exploring Co-Existence in Existence	**9**

V	Natural Acceptance of Human Values Definitiveness of (Ethical) Human Conduct Exploring Ethical Human Conduct A Basis for Humanistic Education,Humanistic Constitution and Universal Human Order Competence in Professional Ethics Exploring Humanistic Models in Education Holistic Technologies, Production Systems and Management-Models- Typical Case Studies Strategies for Transition towards Value –based Life and Profession Exploring Steps of Transition towards Universal Human Order	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment		
Continuous Assessment Test (1 No)	:	10 marks
Assignment/Project/Case study etc.	:	20 marks
Self-Assessment	:	5 marks
Peer Assessment	:	5 marks
Peer Assessment can be done on group-wise basis by dividing the class into suitable groups		
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
TOTAL	**:**	**100 marks**

Assessment Pattern can be modified (if needed), subject to the approval of the Committees Concerned.

END SEMESTER EXAMINATION

The End semester examination will be conducted by the faculty. The examination will be for three hours and 60 marks.

MODE OF CONDUCT OF COURSE (L-T- P: 2 – 1 - 0)

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. Depending on the nature of topics, worksheets, home assignment and/or activity are included.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ESL2NC	INDUSTRIAL SAFETY ENGINEERING	ESC	2	1	0	0	1	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the concepts of safety engineering and identify possible safety requirements. It introduces students to the various safety equipment and precautions. After this course, students will be able to recognize similar safety problems in real-world situations and respond accordingly

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the theories of accident causation and preventive measures ofindustrial accidents	Understand
CO2	Explain personal protective equipment, its selection, safety performance& indicators and importance of housekeeping.	Understand
CO3	Explain the various hazards and associated safety measures in construction industries.	Understand
CO4	Explain various hazards associated with different machines and mechanical.	Understand
CO5	Explain different hazard identification tools in different industries withthe knowledge of different types of chemical hazards	Understand

iii) SYLLABUS

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management.

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –Temporary Structures. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards anddevices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. . HearingConservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, MaterialSafety Data Sheets.

iv) a) TEXTBOOKS

1. R.K Jain, Industrial Safety, Health and Environment management systems, Khanna Publications, 2000.
2. Paul S V, Safety management System and Documentation training Programme handbook, CBS Publication, 2000.
3. Krishnan, N.V. Safety management in Industry. Jaico Publishing House, New Delhi, 1997.

b) REFERENCES

1. Guidelines for Process Hazards Analysis (PHA, HAZOP), Hazards Identification, and RiskAnalysis, CRC Press 2018.
2. Safety Management System and Documentation Training Programme Handbook, CBS Publishers & Distributors, 2019.
3. Hazards and Safety in Process Industries - Case Studies, CRC Press, 2021.

v) COURSE PLAN

Module	Contents	No. of hours
I	Need for safety- Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation - Safety, organization- objectives, types, functions, Role of management - supervisors, workers, unions, government and voluntary agencies in safety. Safety policy- Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.	9
II	Personal protection in the work environment -Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance - Frequency rate, severity rate, incidence rate, activity rate. Housekeeping- Responsibility of management and employees. Advantagesof good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits.	9
III	Introduction to construction - industry and safety issues in construction. Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds. Tunneling – Blasting , Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	9
IV	Machinery safeguard-Point-of-Operation,	9

	Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions ofGas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements- wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	
V	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis. Hazard and Operability study (HAZOP)) – methodology, criticality analysis,corrective action and follow-up. Control of Chemical Hazards- Hazardous properties of chemicals, Material Safety Data Sheets	**9**
	Total Hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 100: 0

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
Final Examination (Summative)	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1½ hours
Topics: 2 ½ modules

NO END SEMESTER EXAMINATION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEP20C	MEASUREMENTS LAB	PCC	0	0	2	0	1	2023

i) COURSE OVERVIEW: The main objective of the course is to expose the students to hands-on experience of various measuring devices and measurements, standardization and calibration of meters, characteristics of transducers.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Develop test set up to calibrate various meters used in electrical systems.	Apply
CO2	Identify transformer parameters, electrical parameters and power in single and three phase circuits.	Apply
CO3	Choose methods to extend the range of ammeter and voltmeter.	Apply
CO4	Develop the electrical characteristics of transducers	Apply
CO5	Develop the magnetic characteristics of various specimens.	Apply

iii) LIST OF EXPERIMENTS

1. Determination of impedance, admittance and power factor in RLC series/ parallel circuits.
2. 3-phase power measurement using a two-wattmeter method and determination of reactive/apparent power drawn.
3. Resistance measurement using Kelvin's Double Bridge and extension of range of Ammeters.
4. Resistance measurement using Wheatstone's bridge and extension of range of Voltmeters.
5. Extension of instrument range by using Instrument transformers (CT and PT).
6. Calibration of ammeter using Slide Wire potentiometer.
7. Calibration of voltmeter using Vernier Potentiometer.
8. Determination of B-H curve a magnetic specimen.
9. Measurement of Self-inductance, Mutual inductance and Coupling coefficient of a 1-phase transformer.
10. Set Up a circuit to determine unknown capacitance.
11. Determination of characteristics of LVDT and Load-cell.
12. Determination of characteristics of Thermistor, Thermocouple and RTD.
13. Demo Experiments:
14. (a) Measurement of energy using Electronic Energy meter
15. (b) Measurement of electrical variables using DSO.

iv) REFERENCES

1) Sawhney A. K., "A course in Electrical and Electronic Measurements and instrumentation", Dhanpat Rai, 10th Edition, 1994.

2) Golding E. W., "Electrical Measurements & Measuring Instruments", AH WHEELER & Company, 5th Edition 1993.
3) Gupta J. B., "A course in Electrical & Electronic Measurement & Instrumentation", S K Kataria & Sons, 2008.

v) COURSE PLAN

Expt. No.	Contents	No. of hours
I	Determination of impedance, admittance and power factor in RLC series/ parallel circuits.	2
II	3-phase power measurement using two-wattmeter method and determination of reactive/apparent power drawn	2
III	Resistance measurement using Kelvin's Double Bridge and extension of range of ammeters.	2
IV	Resistance measurement using Wheatstone's Bridge and extension of range of voltmeters.	2
V	Extension of instrument range by using Instrument transformers (CT and PT).	2
VI	Calibration of Ammeter using Slide Wire Potentiometer.	2
VII	Calibration of Voltmeter using Vernier Potentiometer.	2
VIII	Calibration of 1-phase Energy meter by direct loading	2
IX	Measurement of Self-inductance, Mutual inductance and Coupling coefficient of a 1-phase transformer.	2
X	Determination of B-H curve of a magnetic specimen.	2
XI	Determination of characteristics of LVDT and Load-cell.	2
XII	Determination of characteristics of Thermistor, Thermocouple and RTD.	2
XIII	Calibration of 1-phase Energy meter using phantom loading	2
XIV	Set up a circuit to measure unknown capacitance using Schering's bridge	2
XV	Demo Experiments/Simulation study: (a) Measurement of energy using Electronic Energy meter (b) Measurement of electrical variables using DSO	2
	Total Hours	**30**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 5 marks
Continuous Assessment	: 55 marks
Final Assessment	: 40 marks
Total	**: 100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEP20D	ELECTRONIC DEVICES AND CIRCUITS LAB	PCC	0	0	2	0	1	2023

i) COURSE OVERVIEW:

The main objective of the course is to expose the students to hands-on experience of designing and testing various electronic circuits and to validate the results.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Choose suitable electronic components according to the given requirements.	Apply
CO2	Develop and test voltage regulator using Zener diodes.	Apply
CO3	Construct and test amplifier circuits using BJT and JFET.	Apply
CO4	Model and test oscillator circuits using BJT and Op-amp.	Apply
CO5	Build and test various waveform generation circuits using Op-amps, Comparators and 555 timer IC packages.	Apply
CO6	Utilize simulation software to simulate electronic circuits.	Apply

iii) LIST OF EXPERIMENTS

- Clipping and Clamping circuits using diodes – 2 sessions
- Design and testing of Shunt Zener and Series voltage regulator – 2 sessions
- Frequency response of RC coupled amplifier using BJT in CE configuration
- Frequency response of RC coupled amplifier using JFET in CS configuration
- Determination of Op-amp parameters.
- Design and testing of RC phase shift and Weinbridge oscillator using op-amp - 2 sessions
- Basic op-amp circuits- 3 sessions
- Design of Astable and Monostable Multivibrators using 555 timer IC
- Square wave and Triangular waveform generator using op-amp
- Project/case study

iv) REFERENCES

1) Boylestad R. L. and Nashelsky L., Electronic Devices and Circuit Theory, Pearson Education, 10th Edition, 2009.
2) Floyd T. L., Fundamentals of Analog Circuits, Pearson Education, 2012.
3) Theraja B. L., Sedha R. S., Principles of Electronic Devices & Circuits, S. Chand Limited, 2007.
4) Roy D. C. and Jain S. B., Linear Integrated Circuits, New Age International, 3rd Edition, 2010.

v) COURSE PLAN

Expt. No.	List of exercises/Experiments	No. of hours
I	Clipping circuits using diodes	2
II	Clamping circuits using diodes	2
III	Design and testing of shunt Zener voltage regulator	2
IV	Design and testing of Series voltage regulator using Zener diode	2
V	RC coupled amplifier using BJT in CE configuration-Measurement of gain, BW and plotting of frequency response.	2
VI	JFET amplifier - Measurement of gain, BW and plotting of frequency response.	2
VII	Determination of Op-amp parameters.	2
VIII	Phase shift oscillator using Op-amps.	2
IX	Wein's Bridge oscillator using Op-amps.	2
X	Op-amp circuits – Design and set up of inverting and non-inverting amplifier	2
XI	Basic comparator and Schmitt trigger circuits using Op-amp.	2
XII	Op-amps circuits – Summer, integrator, and differentiator.	2
XIII	Waveform generation– Square, triangular and sawtooth waveform generation using OPAMPs.	2
XIV	Astable and Monostable circuit using 555 IC.	2
XV	Project	2
	Total Hours	**30**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 5 marks
Continuous Assessment	: 55 marks
Final Assessment	: 40 marks
Total	**: 100 marks**

B.TECH S4 MINORS

Basket	Course Code	Course Name	L-T-P-J	Credits
I	23EEL2MB	Hardware Interfacing using Arduino-C Platform	3-0-0-0	3
II	23EEL2MD	Electric Power Supply and Distribution Systems	3-0-0-0	3
III	23EEL2MF	Renewable Energy in Power Grids	3-0-0-0	3
IV	23EEL2MH	Power Electronics and Energy Storage Devices	3-0-0-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MB	HARDWARE INTERFACING USING ARDUINO-C PLATFORM	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to learn how the Arduino platform works in terms of the physical board and libraries and the IDE (Integrated Development Environment). The course will cover programming the Arduino using C code and accessing the pins on the board via the software to control external devices. This course also provides an Introduction to the shields used to extend the capabilities of an Arduino based system.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the composition of the Arduino development board and Arduino IDE.	Understand
CO2	Develop basic Embedded C programming used in Arduino.	Apply
CO3	Explain the Debugging process and basics of serial communication in Arduino	Understand
CO4	Interpret the Interfacing of various sensors and actuators with Arduino	Understand
CO5	Explain the shields used to extend the capabilities of an Arduino based system.	Understand

iii) SYLLABUS

Arduino platform – Arduino Board, Direct programming, Arduino Schematics, Arduino IDE, Compiling Code, Arduino Shields and library, Arduino basic set up, C Programming – Variables, Operators, Conditionals, Loops, Functions, Global Variables. Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop , Serial on Arduino, Reading from Serial, Electrical circuits - Electrical properties - Arduino tool chain, Cross compilation, Arduino sketches, Classes, Sketch structure, Pins, Input and output, Blink example, Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop , Serial on Arduino, Reading from Serial Electrical circuits

iv) (a) TEXT BOOKS

1) Banzi Massimo, “Getting Started with Arduino: The Open Source”, Shroff Publishers and Distributors Pvt. Ltd. ,3rd Edition, 2015.
2) Ashwin Pajankar, “ARDUINO Made Simple”, BPB Publication, 1st Edition, January 2018.
3) Michael Margolis, “Arduino Cookbook”, O’Reily Publication, 2nd Edition, December 2011.

(b) REFERENCES

1) Jeremy Blum, "Exploring Arduino: Tools and Techniques for Engineering Wizardry", Wiley Publications, 1st Edition, 2013.
2) John Nussey, "Arduino for Dummies", 2nd Edition, Kindle.
3) Mark Geddes, "Arduino Project Handbook: 25 practical projects to get you started",1st Edition, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	Arduino platform – Arduino Board, Direct programming, Arduino Schematics, Arduino IDE, Compiling Code, Arduino Shields and library, Arduino basic setup	**9**
II	C Programming – Variables, Operators, Conditionals, Loops, Functions, Global Variables. Arduino tool chain, Cross compilation, Arduino sketches, Classes, Sketch structure, Pins, Input and output, Blink example	**9**
III	Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop, Serial on Arduino, Reading from Serial Electrical circuits- Electrical properties -Ohm's Law-Electrical Components-Diodes –Switches, Potentiometers, Push Button -Wiring	**10**
IV	Sensors- Resistive Sensors- Actuators - Analog Actuators-Pulse Width Modulation - Making Sounds Arduino libraries- EEPROM-Masking – I2C Communication – I2C Transactions – Sending bits – Wire library – Master Communication – Slave operation.	**9**
V	Arduino Shields – Ethernet Shield – Ethernet library – Client examples – Ethernet server – WiFi Shield.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MD	ELECTRIC POWER SUPPLY AND DISTRIBUTION SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The aim of this course is to provide a comprehensive understanding of the various components, characteristics, and technologies involved in electrical power generation, transmission, distribution and management.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Compare the efficiency and reliability of various electrical power generation and transmission methods and technologies.	Understand
CO2	Apply load flow analysis, state estimation, short circuit analysis, stability analysis and harmonic analysis in power systems.	Apply
CO3	Explain generation control and dispatch, load control, power system protection and stability analysis.	Understand
CO4	Illustrate the characteristics and benefits of distributed energy resources, and the various aspects of microgrids.	Understand
CO5	Explain smart grid technologies and future trends in electrical power supply systems.	Understand

iii) SYLLABUS

Introduction to Electric Power Supply Systems, Overview of electrical power systems, Electrical power generation methods and technologies, AC/DC transmission and distribution systems

Power System Analysis: Load flow analysis, State estimation, Short circuit analysis, Harmonic analysis

Power System Control and Protection, Generation control and dispatch, Load control, Power system protection, Power system stability analysis

Distributed Energy Resources and Microgrids, Overview of distributed energy resources, Types of microgrids and their applications, Control, and protection of microgrids, Integration of microgrids with the grid

Emerging Technologies in Electric Power Supply Systems, Smart grid technologies, Energy storage systems and their applications. Future trends and developments in electrical power supply systems.

iv) (a) TEXT BOOKS

1) Ned Mohan, “Electric Power Systems: A first Course”, Wiley India, 2012.

2) J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, "Power System Analysis and Design", 4th Edition, Thomson learning, 2008.
3) V.K. Mehta and Rohit Mehta, "Principles of Electric Power Systems", 3rd Edition, S. Chand Publications, 2005.
4) James L. Kirtley, "Electric Power Principles: Sources, Conversion, Distribution and Use", 2nd Edition, Wiley Publication, 2020.

(b) REFERENCES

1) Ned Mohan, "Electric Power Systems: A First Course", John Wiley and Sons Inc., 2012.
2) F C Chan, "Electric Power Distribution Systems", 3rd Edition, McGraw Hill, 1994.
3) K.R. Padiyar, "Power System Dynamics: Stability and control", Anshan Ltd., 2004.
4) Turan Gonen, "Electric Power Distribution Engineering", 3rd Edition, CRC Press, 2014.
5) James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley - IEEE Press, 2012.
6) "Handbook on Microgrids for power quality", Asian Development bank.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of electrical power systems**: Types of electrical power systems, components of power systems, power system characteristics. Electrical power generation methods and technologies: Conventional power generation (thermal, hydro, nuclear), renewable energy sources (solar, wind, geothermal). AC/DC transmission and distribution systems: Advantages and disadvantages of AC and DC transmission, high voltage AC and DC transmission, sub-transmission, and distribution systems	**8**
II	**Load flow analysis:** Load flow equations, Newton-Raphson method, Gauss-Seidel method, Decoupled load flow method, fast decoupled load flow method. **State estimation:** State estimation theory, weighted least squares state estimation, Kalman filtering. **Short circuit analysis:** Symmetrical components, sequence impedance, fault analysis, symmetrical fault analysis, unsymmetrical fault analysis. **Harmonic analysis**: Harmonic sources, harmonics in power systems, power system harmonics standards, harmonic mitigation techniques.	**12**
III	**Generation control and dispatch:** Power system control, power system stability, generation control and dispatch, economic dispatch. **Load control**: Load control techniques, direct load control, indirect load control, real-time pricing. **Power system protection**: Principles of power system protection, protection zones, relay types, protection coordination.	**9**

	Power system stability analysis: Transient stability analysis, steady-state stability analysis, dynamic stability analysis.	
IV	**Overview of distributed energy resources:** Characteristics of distributed energy resources, benefits and challenges of distributed energy resources. **Types of microgrids and their applications:** Types of microgrids, microgrid topologies, microgrid control and protection, microgrid planning and design. **Control and protection of microgrids:** Microgrid control, microgrid protection, microgrid stability, microgrid reliability. **Integration of microgrids with the grid:** Integration of microgrids with the main grid, microgrid interconnection, microgrid power quality, microgrid market integration.	**8**
V	**Smart grid technologies:** Smart grid concepts, communication technologies for the smart grid, smart grid applications, smart grid security. **Energy storage systems and their applications**: Energy storage systems, applications of energy storage systems, energy storage system design and analysis, energy storage system control and management. **Future trends and developments in electrical power supply systems**: Future trends in electrical power supply systems, energy systems integration, energy systems optimization, energy systems automation.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MF	RENEWABLE ENERGY IN POWER GRIDS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental concepts of the integration of renewable energy sources to power grids. The course also intends to cover the basic concepts of various power converter circuits for renewable energy systems.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the basic concepts of Distributed Generation and Microgrids.	Understand
CO2	Illustrate the various types of Distributed Energy Resources in Microgrids.	Understand
CO3	Explain the various protection issues of microgrids and the impact of DG integration on power quality.	Understand
CO4	Illustrate the working of DC-DC converters for solar photovoltaic applications	Understand
CO5	Illustrate the working of Voltage Source inverters	Understand

iii) SYLLABUS

Distributed generation and Microgrid concept - Distributed generation, Need for integration of Distributed Energy Resources, Active distribution network, Concept of Microgrid.

Distributed energy resources - Combined heat and power systems, Wind energy conversion systems, Solar Photovoltaic systems, Small-scale hydroelectric power generation, Storage devices. Protection Issues for Microgrids – Islanding.

Impact of DG Integration on Power Quality - Introduction, Power Quality Disturbances-Power quality sensitive customers, Existing power quality improvement technologies, Impact of DG Integration.

Power Electronics interface for distributed generation – Ideal Switch, Types of Power Semiconductor Devices. DC-DC Converters – Buck, Boost and Buck-Boost topologies.

Switched Mode Inverters - Single phase half bridge, full bridge and three phase bridge Voltage Source Inverters, AC-AC Converters - Grid integrated wind energy conversion systems, single phase and three phase AC voltage controllers.

iv) (a) TEXT BOOKS

1) Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, Wiley Publications, 3rd Edition, 2019.

2) Chowdhury S., Chowdhury S. P., Crossley P., "Microgrids and Active Distribution", Institution of Engineering and Technology, 2009.
3) Dugan R. C., Granaghen M. F., Beaty H. W., "Electrical Power System Quality", McGraw- Hill, 2nd Edition, 2017.
4) Ned Mohan, Tore M. Undeland, William P. Riobbins, "Power Electronics: Converters, Applications, and Design", John Wiley and Sons Inc., New York, 3rd Edition, 2009.
5) Robert W. Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, 3rd Edition, 2022.

(b) REFERENCES

1) James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley IEEE Press, 2015.
2) Remus Teodorescu, MarCOLiserre, Pedro Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems", Wiley Publications, 1st Edition, 2011.
3) Rashid M. H., "Power Electronics – Circuits, Devices and Applications", Prentice Hall of India, New Delhi, 4th Edition, 2014.
4) Robert Bausiere, Francis Labrique, Guy Seguier, "Power Electronic Converters: DC-DC Conversion", Springer, 2013.
5) Bimbhra P. S., "Power Electronics", Khanna Publishers, New Delhi, 6th Edition, 2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Distributed generation and Microgrid concept –** Distributed generation, Need for integration of Distributed Energy Resources, Active distribution network, Concept of Microgrid, A typical Microgrid configuration, Technical and economic advantages of Microgrid, Challenges and disadvantages of Microgrid development, Dynamic interactions of Microgrid with main grid.	**9**
II	**Distributed energy resources –** Introduction, Combined heat and power (CHP) systems, Wind energy conversion systems (WECS), Solar photovoltaic (PV) systems, Small-scale hydroelectric power generation. **Protection Issues for Microgrids –** Introduction, Islanding: separation from utility, Different islanding detection methods, Major protection issues of stand-alone Microgrid - Microgrid distribution system protection, Protection of microsources.	**10**
III	**Impact of DG Integration on Power Quality –** Introduction, Power Quality Disturbances- Transients, Voltage sags and swells, Over-voltages and under-voltages, Outage, Harmonic distortion, Voltage notching, Flicker, Electrical noise, Power quality sensitive customers,	**9**

	Existing power quality improvement technologies, Impact of DG Integration.	
IV	**DC-DC converters for distributed generation –** Power Devices: The ideal switch, Characteristics of ideal switches, Types of Power Semiconductor Devices - Power ratings. Block diagram of solar photovoltaic system, Types of solar PV system-stand-alone operation and grid integrated solar PV system, Need for DC-DC converters, Buck, Boost and Buck-Boost topologies.	**9**
V	**Voltage Source Inverters –** Single phase half bridge, full bridge and three phase bridge Voltage Source Inverters-square wave operation, PWM inverters, Grid connected inverters.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MH	POWER ELECTRONICS AND ENERGY STORAGE DEVICES	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental concepts of Power Electronic Devices. It also includes the circuit analysis of various power converter circuits. The course also provides an insight into the different energy storage devices.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the operation of modern power semiconductor devices and its characteristics.	Understand
CO2	Illustrate the working of controlled rectifiers.	Understand
CO3	Explain the working of AC voltage controllers and inverters	Understand
CO4	Choose different DC-DC converters based on their performance and applications.	Apply
CO5	Summarize different energy storage techniques	Understand

iii) SYLLABUS

Structure and principle of operation of power devices: Power diode, Power MOSFET & IGBT – switching characteristics - comparison, SiC, GaN

SCR- Structure, characteristics di/dt& dv/dt protection – Turn-on methods of SCR, Gate drive circuit: Triggering circuit-gate drive circuit-Isolation

AC-DC converters: Single phase half wave controlled; fully controlled, semi controlled ac-dc converter Three phase full wave Controlled converter

AC voltage controllers: Single phase AC voltage controller with R & RL load.

Inverters –Single phase half bridge and full bridge inverter, Three Phase inverters

DC choppers–Step up chopper –step down chopper -buck &boost switching regulators

Energy Storage: Battery based energy storage -Fuel Cell based energy storage, Super capacitor and Hydrogen energy storage. Hybridization of different energy storage devices.

iv) (a) TEXT BOOKS

1) Rashid M H, “Power Electronics – Circuits, Devices and Applications”, Prentice Hall of India, New Delhi, 4th Edition, 2014.
2) M.D. Singh and K.B. Khanchandani, “Power Electronics”, Tata McGraw Hills Publishing Company Limited, 2nd Edition, 2006.

(b) REFERENCES

1) Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics: Converters, Applications, and Design”, Wiley India, 3rd Edition, 2018.

2) Dubey G K, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd Edition, 2012.
3) Robert W. Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, 3rd Edition, 2001.
4) Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
5) A.G. Ter-Gazarian, "Energy Storage for Power Systems", 2nd Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Structure and principle of operation of power devices**- Power Diode, Power MOSFET & IGBT –Basic principles of wideband gap devices-SiC, GaN. **SCR-** Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt v dv/dt protection – Turn-on methods of SCR. **Gate triggering circuits**- Requirements of isolation and synchronization in gate drive circuits, Opto and pulse transformer-based isolation.	**9**
II	**Controlled Rectifiers (Single Phase)** – Half-wave controlled rectifier with R load– Fully controlled and half controlled bridge rectifier with R, RL (continuous conduction) – Average Output voltage equation. **Controlled Rectifiers (3-Phase) -** 3-phase half-wave controlled rectifier with R load – Fully controlled bridge converter with RLE load (continuous conduction, ripple free) – Output voltage equation-Waveforms for various triggering angles (detailed mathematical analysis not required).	**10**
III	**AC voltage controllers (ACVC)** – 1-phase full-wave ACVC with R, & RL loads – Waveforms – RMS output voltage **Inverters** – Voltage Source Inverters– 1-phase half-bridge & full bridge inverter with R and RL loads – THD in output voltage – 3-phase bridge inverter with R load – 120° and 180° conduction modes–Pulse width modulation techniques	**9**
IV	**DC-DC converters** – Step down and Step up choppers – Single-quadrant, Two-quadrant and Four quadrant chopper – Pulse width modulation & current limit control in dc-dc converters. **Switching regulators** – Buck, Boost–Operation with continuous conduction mode – Waveforms	**9**
V	**Energy Storage**: Energy Storage Requirements, Battery based energy storage -Battery parameters: C-rating -SoC- DoD- Specific Energy- Specific power, Fuel Cell based energy storage, Super capacitor and Hydrogen energy storage. Hybridization of different energy storage devices,	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

B.TECH S4 HONOURS

Group	Course Code	Course Name	L-T-P-J	Credits
I/II/III	23EEL2MB 23EEL2MD 23EEL2MF	Network Analysis and Synthesis	2-1-0-0	3
IV	23EEL2HH	Modelling and Analysis of Electrical Machines	2-1-0-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MB 23EEL2MD 23EEL2MF	NETWORK ANALYSIS AND SYNTHESIS	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW: This course is designed with the objective of expanding the student's knowledge in network analysis beyond the basic topics. It includes advanced topics in network analysis, Fourier analysis, basics of filter design and network synthesis concepts. This course would help students to explore more advanced concepts in the analysis of complex networks.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Apply Kirchoff's Laws, nodal analysis, and circuit matrix to linear oriented graphs.	Apply
CO2	Apply network topology concepts in the formulation and solution of electric network problems.	Apply
CO3	Apply two-port network parameters in the design and analysis of filter and attenuator networks.	Apply
CO4	Identify the properties and characteristics of network functions and verify the mathematical constraints for their physical realization.	Apply
CO5	Develop skills to synthesize networks, utilizing LC immittance functions and Foster and Cauer methods for RC and RL networks.	Apply

iii) SYLLABUS

Linear Oriented Graphs -incidence matrix of a linear oriented graph – nodal analysis of networks (independent and dependent sources) – Circuit matrix of linear oriented graph.

Loop analysis of electric networks (with independent and dependent sources) - Planar graphs – Mesh analysis- Duality – Cut set matrix – Relation between circuit, cut set and incidence matrices – Tellegen's theorem.

Two port networks – Image parameter description – Characteristic Impedance and Propagation constant - Filter terminology.

Network Functions – Pole-zero plot – Impulse Response – Hurwitz Polynomial – Positive Real functions. Network Synthesis – Properties - Synthesis of LC, RC and RL networks by Foster I, II and Cauer I, II forms.

iv) (a) TEXT BOOKS

1) Suresh Kumar K. S., "Electric Circuits Analysis", Pearson Education India, 2013.
2) Franklin Kuo, "Network Analysis and Synthesis", 2nd Edition, Wiley India, 1962.
3) Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013.
4) Van Valkenberg, "Network Analysis", Prentice Hall India Learning Private Limited, 3rd Edition, 2011.

(b) REFERENCES

1) Suresh Kumar K. S., "Electric Circuits and Networks", Pearson Education South Asia, 2009.
2) Joseph A. Edminister, Mahmood Nahvi, "Electric Circuits", Mc GrawHill, 7th Edition, 2017.
3) Chakrabarti A., "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co., 7th Revised Edition, 2018.
4) Choudhury Roy D., "Networks and Systems", New Age International Pvt Ltd Publishers, 2nd Edition, 2013.
5) Dr. Gupta B. R., "Network Analysis and Synthesis", S. Chand & Company Ltd, 3rd Edition, 2013.
6) Desoer C. A., Kuh E. S., "Basic Circuit Theory", McGraw-Hill, New York, 1969.
7) Bhattacharya S. K., "Network Analysis and Synthesis", Pearson Education India, 2015.

v) COURSE PLAN

Module	Contents	No. of hours
I	Linear Oriented Graphs -incidence matrix of a linear oriented graph – Kirchoff's Laws in incidence matrix formulation – nodal analysis of networks (independent and dependent sources) – Circuit matrix of linear oriented graph.	**8**
II	Loop analysis of electric networks (with independent and dependent sources) - Planar graphs – Mesh analysis- Duality – Cut set matrix - Fundamental cut set matrix –Relation between circuit, cut set and incidence matrices – Tellegen's theorem.	**9**
III	**Two port Networks:** Image parameter description of a reciprocal two-port network - Image impedance - Characteristic impedance - propagation constant - derivation of characteristic impedance and propagation constant for T and Π networks under sinusoidal steady state - Attenuation constant and phase constant. **Filter terminology:** Low pass, high pass, band-pass and band-reject filters - Design of constant k and m-derived filters (Derivation is not necessary).	**10**
IV	**Network Functions** Review of Network functions for one port and two port networks – pole-zero location for driving point and transfer functions - Impulse response of Network functions from pole-zero plots - Sinusoidal steady-state frequency response from pole-zero plots. Hurwitz polynomials – properties - Positive real functions – Properties of positive real functions – Necessary and sufficient conditions for positive real functions.	**9**
V	**Network Synthesis** Synthesis of one-port network – Properties of LC immittance functions - Synthesis of LC Driving point immittance -	**9**

	Properties of RL and RC Driving point immittance, Synthesis of RC and RL networks - by Foster and Cauer methods - Form I and II.	
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2HH	MODELLING AND ANALYSIS OF ELECTRIC MACHINES	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The main goal of this course is to expose the students to the fundamental concepts and trends in electric and hybrid vehicles. It gives an insight into the drive system, battery management system and energy sources used in electric vehicles. It also intends to deliver various communication protocols.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Develop the basic two pole model representation of electrical machines	Apply
CO2	Develop the linear transformation equations of rotating electrical machines incorporating the concept of power invariance.	Apply
CO3	Apply linear transformation for the steady state and transient analysis of different types of rotating electrical machines.	Apply

iii) SYLLABUS

Unified approach to the analysis of electrical machine performance - basic two pole model of rotating machines- per unit system

Primitive machine - transformer and rotational voltages in the armature voltage and torque equations resistance, inductance and torque matrix.

Transformations - passive linear transformation in machines- Park's transformation- invariance of power.

DC Machines- Application of generalized theory to separately excited, shunt and series machines- Steady state and transient analysis, transfer functions.

Synchronous Machines- reactance and time constants-Primitive machine model of synchronous machine - Balanced steady state analysis-power angle curves-Transient analysis.

Induction Machines- Primitive machine representation- Steady State Operation- Equivalent circuit. Double cage rotor representation- Single phase induction motor- Voltage and Torque equations.

iv) (a) TEXT BOOKS

1) Bhimbra P. S., "Generalized Theory of Electrical Machines", Khanna Publishers, 6th Edition, Delhi 2017.
2) Charles V. Johnes, Unified Theory of Electrical Machines. New York, Plenum Press,1985.

3) Bernad Adkins, Ronald G Harley, General theory of AC machines. London, Springer Publications,2013.

(b) REFERENCES

1) Alexander S Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill, 2nd revised Edition, 2001.
2) Charles Concordia, Synchronous Machines- Theory and Performance, John Wiley and Sons Incorporate, Newyork.1988.
3) M. G. Say, Introduction to Unified Theory of Electrical Machine, Pitman Publishing,1978.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Unified approach to the analysis of electrical machine performance** - per unit system - Basic two pole model of rotating machines - Primitive machine - Conventions - transformer and rotational voltages in the armature voltage and torque equations, resistance, inductance and torque matrix.	**9**
II	**Transformations** - Passive linear transformation in machines - invariance of power transformation from a displaced brush axis-transformation from three phase to two phase and from rotating axes to stationary axes-Physical concept of Park's transformation.	**9**
III	**DC Machines:** Application of generalized theory to separately excited DC generator: steady state and transient analysis, Separately excited DC motor- steady state and transient analysis, Transfer function of separately excited DC generator and motor-DC shunt and series motors: Steady state analysis and characteristics.	**9**
IV	**Synchronous Machines:** Synchronous machine reactance and time constants - Primitive machine model of synchronous machine with damper windings on both axes. Balanced steady state analysis-power angle curves. Induction Machines: Primitive machine representation. Transformation - Steady state operation-Equivalent circuit. Torque slip characteristics.	**10**
V	**Single phase induction motor**- Revolving Field Theory equivalent circuit- Voltage and Torque equations - Cross field theory-Comparison between single phase and polyphase induction motor.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1 ½ hours
Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours